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FRDA REPORT 143

TESTING BACKLOG REFORESTATION OPTIONS

by
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FOREST RESOURCE DEVELOPMENT AGREEMENT

Canada

BC

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Abstract

A demonstration trial on a backlog site near Prince George, initiated by Lakeland Mills Ltd., has shown that plowing can be a successful form of site preparation for interior spruce regeneration. The site is seasonally droughty and has dense, shrubby, competing vegetation. Seedlings planted following light discing were frequently damaged by growing-season frosts. Light discing exposed little mineral soil. Planting large stock without mechanical site treatment was not a viable option on this site because browsing by hares devastated seedlings in untreated plots. Aerial herbicide spraying did not reduce vegetation cover sufficiently to afford protection from browsing. Application of slow-release fertilizer at the time of planting was ineffective in accelerating seedling growth.

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Introduction

Recognition that the extensive NSR lands in British Columbia were major impediments to sustained forest production led to the Canada-British Columbia Forest Resource Development Agreement. A component of that agreement was support for research aimed at determining methods of reducing the backlog.

A research trial was initiated by Lakeland Mills Ltd. to demonstrate the effectiveness of several treatment options in promoting seedling establishment and early growth. The performance of interior spruce seedlings planted following various treatments has been the measurement of success.

The study area (part of Lot 877A), is located near Shelley, about 30 km northeast of Prince George (Fig. 1). The site is accessed from the Beaver Forest Road at Km 6. When the trial was initiated, the predominant ecosystem was classified as a variant of the SBSe2 subzone, the Spruce - Horsetail - Red Osier Dogwood association. The silty soils are well drained, rich in organic matter and highly productive. The site is essentially level.

The area was logged during the 1930s to remove the heavy cover of interior spruce. Relogging in 1977 removed the residual subalpine fir stand. At the start of the trial the site was densely covered with *Alnus incana*, *Betula papyrifera*, *Populus tremuloides*, *Salix myrtillifolia*, *Cornus serica*, *Lonicera involucrata* and *Rubus parviflorus*.

The presence of a dense, well developed brush layer indicated that planting without site preparation would be unsuccessful. Little natural regeneration had developed since the logging in 1977. It was not recognized at the time that the experiment was initiated in 1985, however, that one of the most important factors related to the absence of regeneration, despite the proximity of a seed source, was a high population of snowshoe hares. Had this been recognized, different experimental options might have been tried. The trial, nevertheless, demonstrated the potential of small mammals to frustrate otherwise suitable reforestation options, such as planting large stock without site treatment.

Progress Reports on this trial have been prepared by Herring (1986), McMinn (1988, 1989) and Watson (1987).

Objectives

1. To determine the effectiveness of several silvicultural systems for reforesting a productive, backlog interior spruce - red osier dogwood site in the SBSe2.

2. To develop this research project as a demonstration site comparing backlog reforestation options for the SBSe2.

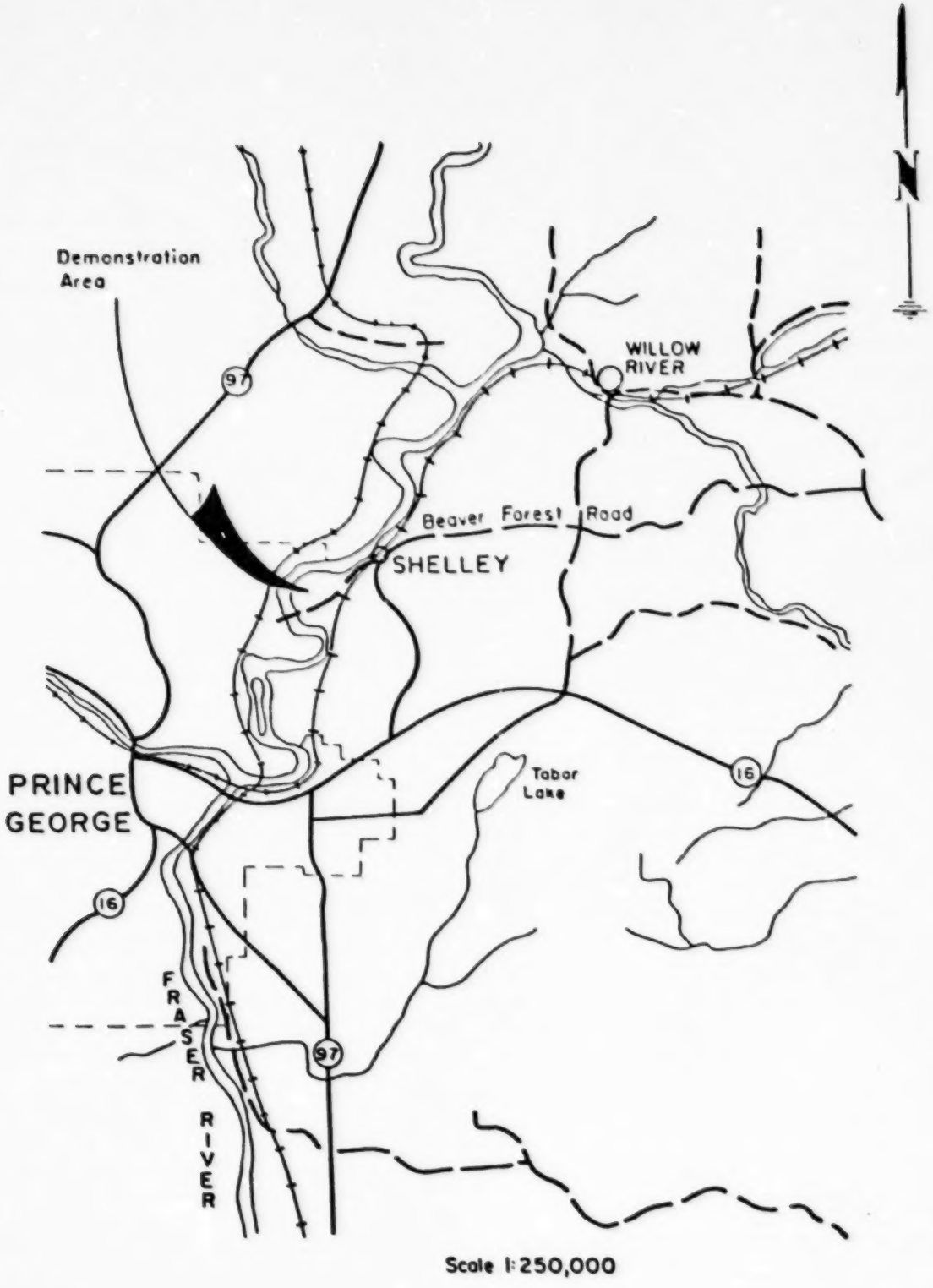

Figure 1. Location of the Shelley Demonstration Area near 6 km on the Beaver Forest Road, east of Prince George.

Treatments And Experimental Design

A split plot, factorial design replicated four times was used (Fig. 2). Plots were aprroximately 30 x 40 m. The treatment options tested were:

Treatment	Code	Plot Number
Plowing, Herbicide, Fertilizer	P H F	12, 23, 30, 48
Plowing, Herbicide, No Fertilizer	P H O	11, 24, 29, 47
Plowing, No Herbicide, Fertilizer	P O F	03, 18, 35, 40
Plowing, No Herbicide, No Fertilizer	P O O	04, 17, 36, 39
Discing, Herbicide, Fertilizer	D H F	07, 20, 27, 45
Discing, Herbicide, No Fertilizer	D H O	08, 19, 28, 46
Discing, No Herbicide, Fertilizer	D O F	02, 13, 34, 42
Discing, No Herbicide, No fertilizer	D O O	01, 14, 33, 41
Untreated, Herbicide, Fertilizer	U H F	10, 22, 25, 44
Untreated, Herbicide, No Fertilizer	U H O	09, 21, 26, 43
Untreated, No Herbicide, Fertilizer	U O F	06, 16, 32, 37
Untreated, No Herbicide, No fertilizer	U O O	05, 15, 31, 38

Plowing: Continuous furrow slices were laid side by side over the entire plot using a 30" single bottom farm plow pulled by a D6 Caterpiller tractor. This treatment resulted in a mineral soil surface layer above a single layer of inverted humus resting on the mineral soil exposed by removing the previous furrow slice. Because the density of the vegetation on the site before treatment interfered somewhat with furrow slices laying flat and because a single bottom plow allows some irregularity in the way furrow slices are laid down, the surface of plowed plots was humpy. Treatment was between 20 and 24 August 1985.

Discing: A 26" light-weight farm disc pulled by a D6 Caterpiller tractor prepared the entire plot. Despite two passes being used to break up the brush and mix the surface organic matter and mineral soil, the surface after treatment was a mixture of organic matter and mineral soil, rather than an essentially mineral soil surface. Treatment was between 20 and 24 August 1985.

Untreated: No mechanical treatment was applied so that soil and vegetation remained undisturbed.

Herbicide: Strips of plots were helicopter sprayed during July 1985 with glyphosphate at a rate of 2.5 kg a.i./ ha in 110 litres of water.

Fertilizer: Following planting, 23.5 g of 18-6-12 Osmocote 9-month release fertilizer was placed in a 10 cm diameter ring around seedlings in the appropriate plots. Fertilizer was applied between 18 and 24 June 1986.

Stock: Seedlings were 1+0 PSB 415 interior spruce. Planting was between 18 and 24 June 1986. Eighty seedlings, at 3 m spacing, were planted in each plot.

1-48 = Plot number
P = plowing; **D** = discing; **U** = no mechanical treatment.
H = herbicide treatment; **F** = fertilizer treatment.

Figure 2. Layout of Plots at the Shelley Demonstration Site. Shaded plots were herbicided.

Assessments

Seedlings: The height, internodal growth and diameter of the inner 48 seedlings on each plot were measured at the end of each growing season for the first four years after planting. Records were taken of frost damage and browsing by hares.

Vegetation: The height and cover of vegetation was assessed in July during the second, third and fourth growing seasons. In each treatment plot, 12 seedling-centred circular plots covering 2000 cm^2 were used to assess vegetation ingrowth.

Observations were analysed by Duncan's Multiple Range Test.

Results

Seedling Survival and Growth

Survival remained high through the fourth growing season for seedlings on the mechanically treated plots (Table 1, Fig. 3). Survival on many of the mechanically untreated plots was low. Repeated removal of tops and lateral branches of seedlings planted in the untreated plots by snowshoe hares was evident and appeared sufficient to be the effective cause of death. Hare damage was especially severe during the winter of 1988/89 (Table 2). Damage to seedlings in the

Table 1. Survival and growth, at the end of the fourth growing season (1989), of interior spruce seedlings planted to assess various site treatment options at the Shelley Test Site.

Treatment	Survival	Total Height	'89 Leader	Diameter	Stem Volume
	%	cm	cm	mm	cm
P[1] H[4] F[5]	97a[7]	62ab	17b	15a	38b
P H O	97a	65a	20a	17a	51a
P O[6] F	98a	59b	17b	13c	28c
P O O	97a	59b	17b	13c	28c
D[2] H F	97a	41cd	10c	11d	15d
D H O	97a	40cd	10c	10c	13d
D O F	97a	43c	11c	11de	15d
D O O	97a	37d	08d	09e	09de
U[3] H F	51c	25e	05e	07f	04e
U H O	60c	22e	05e	07f	03e
U O F	83ab	26e	05e	07f	04e
U O F	81b	24e	05e	06f	04e

[1]P = plowing; [2]D = discing; [3]U = no mechanical treatment;
[4]H = herbicide treatment; [5]F = fertilizer treatment;
[6]O = no herbicide and/or no fertilizer treatment.
[7]Values in a column followed by the same letter are not significantly different (p = 0.05).

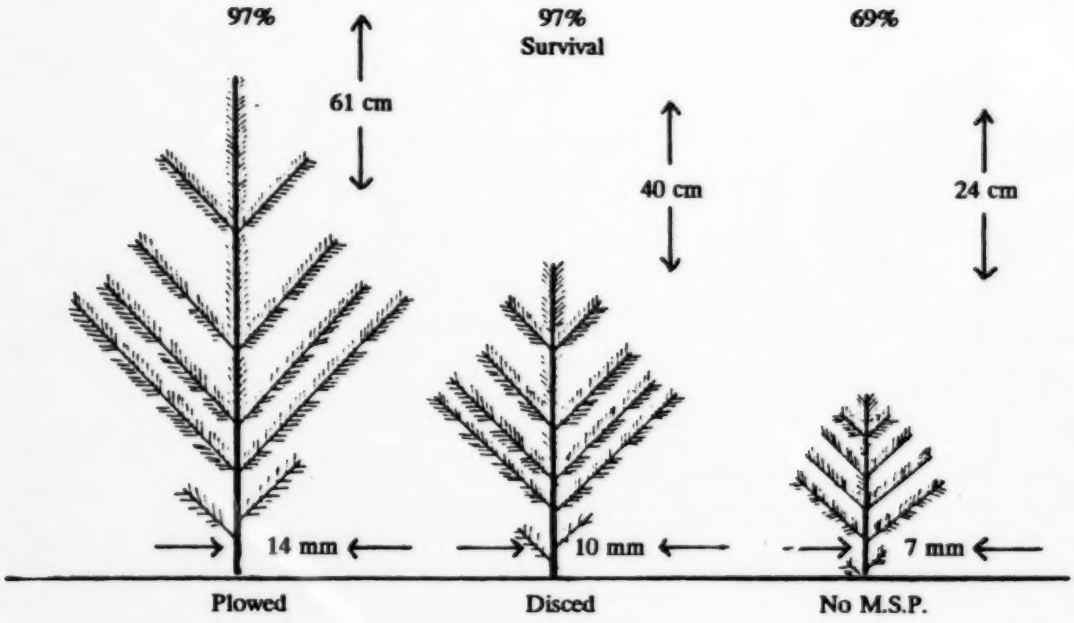

Figure 3. Survival, height and diameter of interior spruce seedlings after four growing seasons following planting in variously treated planting spots at the Shelley Site.

Table 2. Damage to interior spruce seedlings overwinter prior to and during the fourth growing season (1989) at the Shelley Site.

Treatment	Hare Damage		Arrested	Frost Damage	
	Leader	Laterals	Leader	Leader	Laterals
	%	%	%	%	%
P[1] H[4] F[5]	01	17	17	19	79
P H O	08	25	18	10	33
P O[6] F	24	31	09	13	47
P O O	12	19	10	18	54
D[2] H F	31	39	11	23	44
D H O	17	29	09	20	47
D O F	15	23	11	22	59
D O O	21	14	14	22	52
U[3] H F	62	48	03	14	26
U H O	78	89	00	15	23
U O F	62	63	03	01	01
U O O	70	68	03	03	05

[1]P = plowing; [2]D = discing; [3]U = no mechanical treatment;
[4]H = herbicide treatment; [5]F = fertilizer treatment;
[6]O = no herbicide and/or no fertilizer treatment.

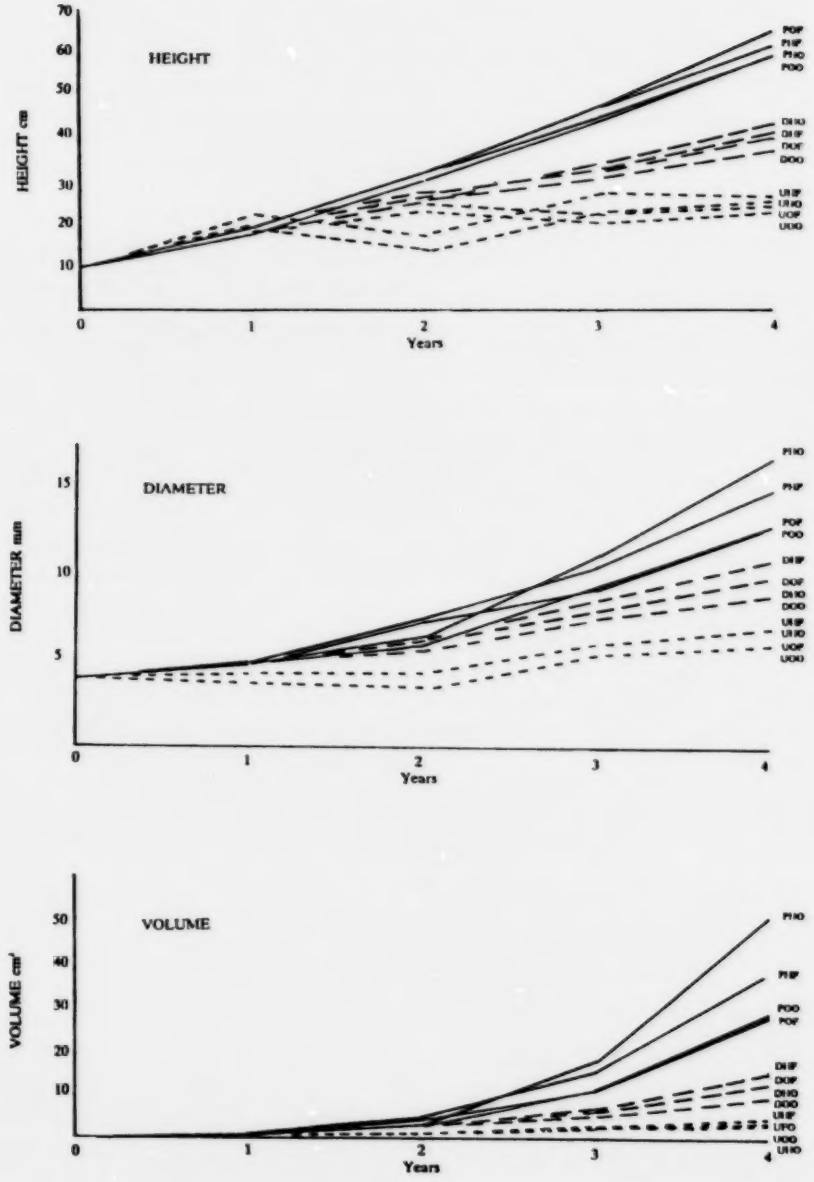

Figure 4. Height, diameter and volume of interior spruce seedlings after four growing seasons following planting in variously treated planting spots at the Shelley Site.

plowing treatment plots was generally light. Even discing seemed to have afforded some protection. The height reduction of seedlings in some untreated plots recorded in the second growing season (Fig. 4) is a consequence of overwinter hare damage. Seedlings on the plowing and discing treatment plots showed no comparable height reduction.

The trends shown in Figure 4 clearly indicate a primary difference related to mechanical treatment or its absence and to the type of mechanical treatment. Differences related to herbicide or fertilizer treatment are secondary and generally not significant.

Conditions during the fall/winter/spring of 1988/89 seemed to result in bud damage which arrested 1989 shoot growth. Damage seemed largely restricted to leaders above the snow pack. Little arrested leader damage occurred to seedlings in the mechanically untreated plots (Table 2).

The Shelley Site is in a frost pocket. Early growing season damage to apical and lateral buds was relatively common. Damage to apical buds was most prevalent in seedlings in the discing treatment plots (Table 2).

Vegetation Ingrowth

During the fourth growing season the average height of seedlings (61 cm) in the plowing treatment plots overtopped the average height (42 cm) of vegetation ingrowth (Tables 1 and 3). Even in the discing treatment, the average height of seedlings (40 cm) was only marginally less than that of the average height of competing vegetation (41 cm). Seedlings (av. height 24 cm) in the mechanically untreated plots remained well overtopped by the competing vegetation (av. height 54 cm). Cover in the untreated plots was also greater than in the plowed plots. Residual aspen, birch, willow and occasionally subalpine fir formed a canopy above the seedlings in half the mechanically untreated plots.

Table 3. Height and cover of competing vegetation 4 growing seasons after various site treatments at the Shelley Site.

Treatment	Vegetation			
	Herbs and shrubs		Trees	
	Height cm	Cover %	Height cm	Cover %
P[1] H[4] F[5]	40cd[7]	61c	-	-
P H O	45bc	59cd	200	1 (1 plot)
P O[6] F	52b	62c	-	-
P O O	32d	49d	-	-
D[2] H F	43bcd	78a	185	45 (2 plots)
D H O	42bcd	73ab	275	40 (2 plots)
D O F	46bc	74ab	-	-
D O O	33d	65bc	250	50 (1 plot)
U[3] H F	44bcd	76a	300	40 (2 plots)
U H O	41bcd	73ab	300	70 (2 plots)
U O F	68a	81a	350	40 (2 plots)
U O O	64a	84a	350	30 (2 plots)

[1]P = plowing; [2]D = discing; [3]U = no mechanical treatment;
[4]H = herbicide treatment; [5]F = fertilizer treatment;
[6]O = no herbicide and/or no fertilizer treatment.
[7]Values in a column followed by the same letter are not significantly different (p = 0.05).

Discussion

The reduced survival of seedlings in the mechanically untreated plots is probably largely a reflection of the reduction in vigour of seedlings due to heavy browsing by hares. Damage overwinter prior to the 1989 growing season was particularly severe. Many seedlings were reduced to little more than a twig with a few needles. The cover afforded by vegetation in the mechanically untreated plots, whether treated or not treated with herbicide, evidently was beneficial to the hare population. Although some hare damage did occur on seedlings in the plowing and discing treatment plots, it was minor compared to the damage to seedlings in the mechanically untreated plots. Average seedling height was likely to have been somewhat reduced, nevertheless.

Frost damage continued to be severe on the discing treatment plots. As noted in previous years, leaders had commonly formed from laterals following frost damage to the original leader. The frequency of frost damage to leaders on the discing treatment plots was high enough to have affected total height growth. Frost damage to seedlings in the mechanically untreated plots was probably less frequent, in part, due to the tree canopy and the relatively dense shrub layer. The frequency of hare damage, however, precludes determination of whether these canopies would have been beneficial because hare damage has been such an overiding detrimental factor.

The high rate of survival and relatively low rates of damage to seedlings in the plowing treatment plots is likely to reflect the favorable temperature characteristics of the bare mineral soil exposed by plowing and the reduced cover which vegetation control by plowing afforded. Discing also apparently reduced vegetation cover sufficiently for hare damage to be relatively minor. This treatment, however, provided inadequate frost protection, possibly because the discing was insufficiently severe for much mineral soil to be exposed. Although seedlings in the discing treatment plots were well established, frost damage, even in spring 1989, appeared to be sufficiently severe to have had a continued negative influence on growth.

The clear superiority of seedlings in the plowing treatment is likely to reflect the reduced damage by frost and by hares compared with the other treatments as well as the inherently favorable growing conditions created by plowing. Plowing apparently gives seedlings on this site optimum conditions for establishment and growth because:

i. soil temperature is enhanced by exposure of mineral soil;
ii. nutrients in the overturned duff and uppermost mineral soil are rendered even more readily accessable by the increased temperature for root growth;
iii. exposure of mineral soil seems to provide protection from growing season frost;
iv. protection from hare browsing is provided by the reduction in cover for hares;
v. reduction in competing vegetation increases soil temperature and reduces competition for soil moisture.

On this droughty site, plowing is likely to be a more favorable site treatment than mounding to form mineral soil capped inverted humus mounds. Seedlings on raised planting spots (mounds) are more likely to be affected by dry soils than seedlings planted level with the general ground level. Plowing also prepares planting spots with only one layer of surface organic matter separating the surface mineral soil layer from the underlying mineral soil. Seedlings planted in such a configuration are less likely to be affected by drought than seedlings separated from the underlying mineral soil by two layers of surface organic matter as is the case with mineral soil capped inverted humus mounds.

While discing did not provide seedlings with as many immediate advantages as plowing, most seedlings in the discing treatment plots were quite healthy at the end of the fourth growing season after planting. Their vigour was surprising since they had been affected by frost during the previous three growing seasons and hare browsing had been appreciable. Discing seemed to provide sufficient control of competing vegetation on this site, even though the intensity of discing

was comparitively low. These results suggests that cross discing with heavy forest discs might be an effective whole site treatment on such a site.

Using stem volume as an integrated assessment of growth performance, treatment with herbicide before mechanical treatment by plowing improved growth. Herbicide treatment before discing did not make a significant difference to seedling performance. Presumably other factors than competing vegetation were sufficiently influential to negate any advantage afforded by herbicide application. Fertilizer application may have improved seedling performance in the discing treatment plots but the differences were not statistically significant at the 95% level.

Conclusions and Recommendations

It would be of interest to follow the future development of this trial to determine whether, given time, seedlings in the discing treatment plots will narrow the present performance difference sufficiently to suggest that either form of mechanical treatment would have been adequately effective. Up to the fourth growing season, plowing is clearly the most favourable treatment. Use of herbicide and fertilizer at the time of planting does not seem to have conferred appreciable benefit. Plowing may well remain the most effective treatment option since the considerable size advantage noted at the end of the third growing season (more than twice the stem volume) has been maintained in the fourth growing season. Plowing is also likely to be more favorable than mineral capped inverted humus mounds on this droughty site. Large stock without mechanical site treatment, with or without herbicide treatment, does not seem to be a viable option during a high part of the hare cycle.

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